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Case Report

Side-branch wire entrapment: Early recognition and management

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ABSTRACT

Side-branch wire (SBW) entrapment has been reported with increasing frequency recently. We report early recognition of SBW entrapment in a 60-year-old woman.

1. Introduction

Guide wire loss through entrapment or fracture is an extremely rare complication during percutaneous coronary intervention (PCI), with an incidence of ~0.2–0.8% [1,2]. Although most major adverse outcomes can be avoided if the guide wire is left alone or the wire remnants are removed through percutaneous or surgical techniques, several life-threatening complications have been reported. Several clinical conditions have been associated with a high risk of guide wire entrapment or fracture. As PCI procedures have recently become increasing complex, a higher frequency of side-branch wire (SBW) entrapment has been reported during bifurcation interventions. We report a case of SBW entrapment involving early recognition in which the wire was successfully removed.

2. Case report

A 60-year-old woman was referred to a cardiology clinic for a preoperative evaluation. The patient had a long-term history of hypertension for which she was prescribed medication. Abdominal sonography revealed a gall bladder stone and surgical intervention was suggested. The patient had reported exertional dyspnea and chest discomfort upon exertion over the past 2 months. A dipyridamole stress myocardial perfusion scan revealed moderate ischemia over the apical area of the patient's left ventricle. Therefore, coronary angiography was done for preoperative evaluation, revealing single coronary artery disease with 80% stenosis of the proximal left anterior descending (LAD) artery at the bifurcation of the first diagonal (D1) branch (Fig. 1). Due to a coronary bifurcation lesion (Medina [1,1,0]), SBW protection with provisional stenting was done. After wiring the LAD and the D1 arteries, we dilated a 3.0 × 15-mm Sprinter balloon (Medtronic, Minneapolis, MN, USA) to 8 atm. After dilation, a dissection at the lesion site was visible. During advancement of a 3.5 × 18-mm Integrity bare metal stent (Medtronic) across the lesion, we felt strong resistance. However, with further support from the guiding catheter, the stent crossed the lesion and was dilated to 8 atm. After the initial inflation, we discovered that the stent was not fully expanded. In addition, we discovered proximal displacement and an increased acute angulation of the SBW at the bifurcation site (Fig. 2). Upon closer inspection with the fluoroscope, we discovered that the SBW was wrapped 270° around the stent, rendering extraction of the SBW highly difficult and posing a high likelihood of wire entrapment. We initially pulled the wire more forcefully with low-pressure dilatation of the stent balloon to protect the LAD stent, but the SBW moved only fractionally. We then inserted a Finecross microcatheter (Terumo, Somerset, NJ, USA) in with the entrapped wire to enlarge the space between the vessel and the stent. We were able to push the microcatheter approximately halfway into

Conflicts of interest: none.

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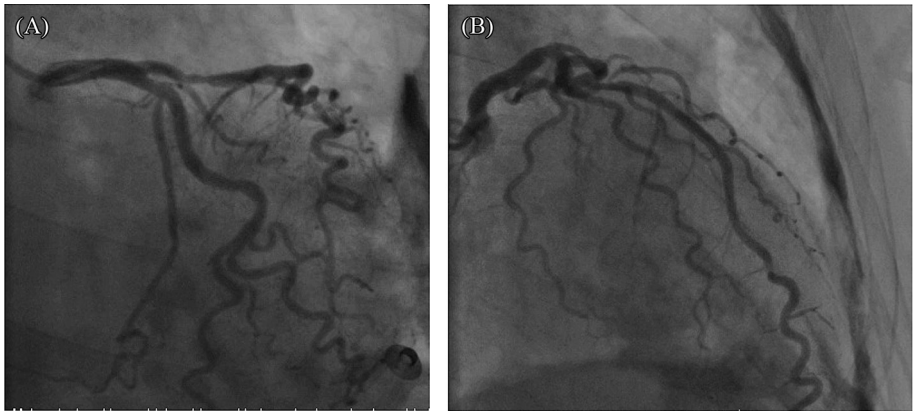

Fig. 1. Right anterior oblique (RAO) caudal view (A) and cranial view (B) demonstrating severe stenosis involving the bifurcation of the LAD and D1 (Medina 1,1,0). D1 = first diagonal; LAD = left anterior descending.

the stent. We then successfully pulled the wire out using greater force. Thereafter, we postdilated the balloon to 16 atm for stent expansion and implanted another 4.0 × 15-mm Integrity stent (Medtronic) near the first stent for dissection in the LAD ostium (Fig. 3). The postPCI course was smooth; the patient was followed up in the cardiology clinic for 6 months without any related complaints.

3. Discussion

Entrapped SBWs occur rarely in clinical practice but are associated with potential morbidity and mortality. Table 1 summarizes the literature on the management and outcomes of entrapped SBWs. After 2007, most reported cases of entrapped wires involved treatment of bifurcation lesions. Percutaneous removal [3–7] and

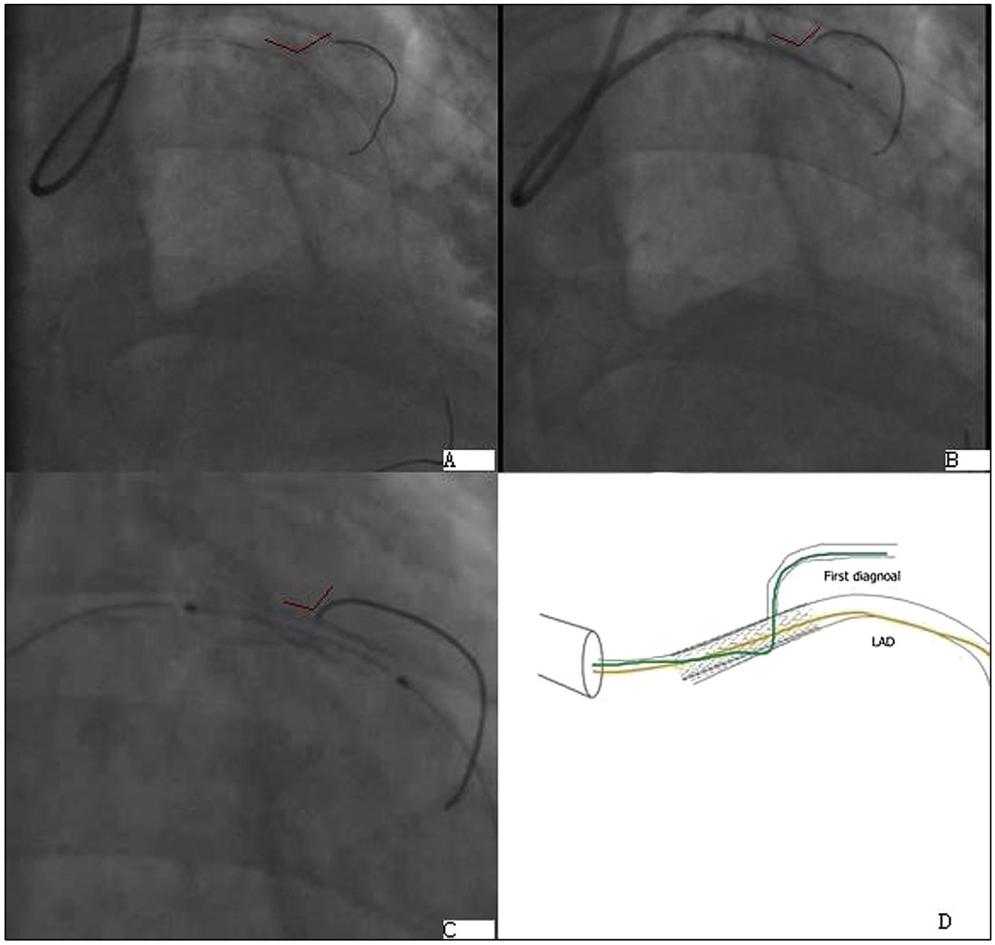

Fig. 2. The angle between the LAD and D1 has become increasingly perpendicular during intervention; (A) after passage of two guide wires in the LAD and D1; (B) pushing the stent to the lesion; (C) dilation of the stent to 8 atm; and (D) after stent deployment, the side branch wire is wrapped 270° around the stent. D1 = first diagonal; LAD = left anterior descending.

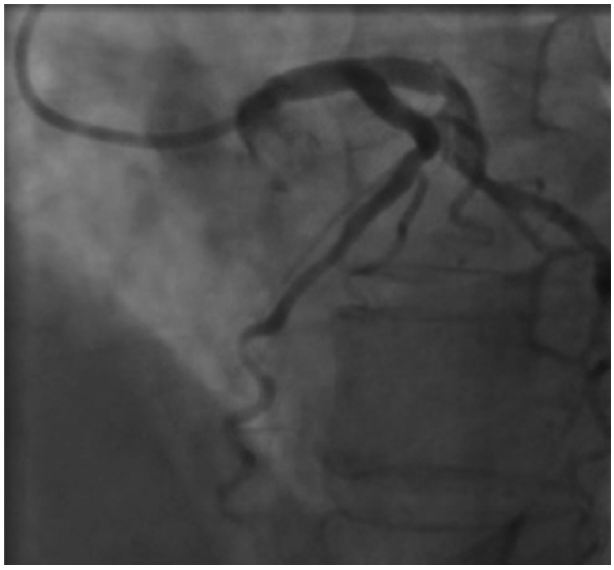

Fig. 3. Final angiogram obtained after removal of the entrapped guide wire and stenting.

surgical removal [8–12] of the trapped wires, and even leaving the wires *in situ* [6,13], result in no major complications in most cases. However, a few life-threatening complications have been reported, such as death from stent thrombosis [8] and unintended stent removal [3]. Therefore, avoidance and early recognition of SBW entrapment is crucial during bifurcation PCI.

Several clinical conditions purportedly increase the risk of wire entrapment or fracture during PCI. Major structural factors causing greater resistance to jailed wire retraction include acute angulation of the wire in a side branch [14], heavy calcification of the target vessel [15], and stent implantation in a curved segment of the main vessel (MV) that transmits a great radial force to the wire [12]. The SBW may also be trapped by stenting with SBW protection, particularly during the use of an oversized stent and/or high-pressure postdilatation after stenting. Furthermore, if there is no retrograde tension on the SBW during advancement of the balloon or stent across the lesion, especially when the advancement faces resistance with persistent forward tension on the SBW, the SBW can loop and wrap around the stent after completing the procedure, making removal of the SBW more difficult. Table 2 summarizes several rules that can be applied to prevent SBW entrapment during PCI for bifurcation lesions. For example, although hydrophilic-coated guide wires perform excellently when crossing tight, complex lesions, they should be avoided because of the infrequent complication of fragmentation, particularly when the distal end of the wire is trapped in small, distal coronary branches. In our case, the angle of the wire at the bifurcation of the LAD and D1 branches became increasingly acute during intervention. Although the stent did not fully expand at a balloon pressure of 8 atm, we attempted to remove the SBW prior to high-pressure balloon inflation, which could have prevented further entrapment of the wire.

When an SBW is trapped, it should not be pulled directly because the increased pulling force at the wire's shaft may cause the distal filament to unravel. Table 3 summarizes management of trapped wires in bifurcation lesions prior to wire fracture. First, a penetrating microcatheter or a low-profile microcatheter above the wire balloon can be advanced over the trapped wire to enlarge the space between the MV wall and the MV stent struts. Next, a 1:1

Table 2
Strategies to avoid and for early recognition of SBW entrapment in bifurcation lesions.

Avoidance of SBW entrapment
Avoid hydrophilic wires
Avoid jailing the wire in multiple overlapping stents
Avoid oversized stents with high pressure prior to SBW removal
Backward traction of SBW during device advancement
Beware resistance with balloon or stent across the lesion
Beware the angle and curve of the wire at the lesion site after ballooning and stenting
Consider the necessity of an SBW
Remember the angle or curve of the SBW
If in doubt, do not pull the jailed SBW forcefully because the wire may fracture or the stent may deform
Early recognition of SBW entrapment
Monitor for abnormal proximal or distal migration of the SBW
Be particularly careful when ballooning, stenting, or advancing any device in bifurcation lesions
Monitor for changes in angulation or curvature of the SBW
If in doubt, use high-resolution imaging or multiple views for imaging

SBW = side branch wire.

Table 1
Review of case reports for side branch wire entrapment during percutaneous coronary intervention for bifurcation lesions.

Authors	Year	Guidewires	Site of trapping	Lesion characteristics	Treatment	Success*	Complication	Survival
Darwazah et al [8]	2007	Asahi Floppy	LAD/diagonal	Bifurcation	Surgical removal	No	Thrombus formation	No
Capuano et al [9]	2008	Abbott Vascular BMW universal	LAD/diagonal	Bifurcation	Surgical removal	Yes	No	Yes
Micovic et al [10]	2009	ATW floppy	LAD/large septal branch	Bifurcation	Surgical removal	Yes	No	Yes
Gagnor et al [3]	2009	Not available	LCX/OM	Bifurcation	Amplatz gooseneck snare	Yes	Unintended stent removal	Yes
Kotoulas et al [11]	2009	Not available	LAD/diagonal	Bifurcation	Surgical removal	Yes	No	Yes
Bonvini et al [4]	2010	BMW guidewire	LCX/OM	Bifurcation	Entrio snare	Yes	No	Yes
Burns et al [5]	2010	Abbott Vascular Balance	LAD/diagonal	Bifurcation	Amplatz gooseneck snare	Yes	No	Yes
Balbi et al [12]	2010	Guidant ACS BMW	LAD/diagonal	Bifurcation	Surgical removal	Yes	No	Yes
Hong et al [6]	2010	BMW guidewire	LAD/diagonal	Bifurcation	Beaded wire rotation/snare	No	No (1 y follow-up)	Yes
Pourmoghaddas et al [13]	2011	Not available	LAD/diagonal	Bifurcation	Conservative management	Observation	No	Yes
Owens et al [7]	2011	BMW guidewire	LAD/diagonal	Bifurcation	Wire and balloon catheter wrap technique	Yes	No	Yes

LAD = left anterior descending artery; LCX = left circumflex artery; OM: obtuse marginal; RCA: right coronary artery.
* Success means successful removal of entrapped wire by percutaneous or surgery techniques.

Table 3
Management of entrapped wires in bifurcation lesions before wire fracture.

Attempt to insert a 1:1 sized balloon into the MV stent to protect the stent with low-pressure dilatation when pulling the entrapped wire.
Insert another wire into the side branch, followed by balloon dilatation to keep the SB patent.
Insert a low-profile balloon, microcatheter, or even a Tornus catheter by using the trapped wire to enlarge the space between the vessel and the stent, then attempt to pull the wire again.
The likelihood of removing the wire intact increases if the pulling force is applied near the retained tip; if possible, pull the wire, engaging the guiding catheter or other supporting catheters.

MV = main vessel; SB = side branch.

sized balloon in the MV stent should be underinflated to protect the MV stent when the trapped wire is pulled. Sakamoto et al [16] reported successfully retrieving a stent-jailed SBW by using a balloon catheter without a protective balloon in the main stent. However, Gagnor et al [3] described unintentionally removing the stent when removing a fractured guide wire. Finally, deep intubation of a guiding catheter or another supporting catheter can be used to reach the proximal part of the stent and transmit a pulling force.

When a trapped wire breaks inside the coronary artery, surgery should be one of the last solutions for wire retrieval. Surgical mortality varies according to the duration, extent, and location of ischemia. Another strategy is to extract the wire using a snare system; however, extraction of entrapped wires requires a free guide wire edge for snare application [7] and may cause vessel injury. Depending on the patient's condition, leaving small guide wire remnants in small side branches has proven safe in several reported cases, especially those involving nonmetallic and hydrophilic guide wire tips [17].

In conclusion, SBW entrapment is likely in angulated or calcified vessels. Early recognition and management prior to SBW fracture in bifurcation lesions is critical to prevent trapping or breaking wires. The use of a microcatheter or balloon catheter for retrieval in stent-jailed side branches is effective.

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